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SYNTHESIS OF GLASS FOR OBTAINING SLAG SITALS BASED ON SLAGS FROM HEAT-AND-POWER PLANTS

E. A. Yatsenko,[1, 2] O. S. Krasnikova,[1] E. B. Zemlyanaya,[1] and I. S. Grushko[1]

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Glass compositions which make it possible to obtain slag sitals based on ash-slag wastes from heat-and-power plants have been developed. The crystallization power of the optimal compositions is studied. The temperature regime for making these glasses is determined to be 40 min at the maximum temperature 1500°C. The glass compositions obtained can be used to synthesize slag sitals.

Key words: slag sitals, ash-slag wastes, crystallization power, glass-making temperature regime.

Investigations concerning the development of resource-conserving technologies for reprocessing ash-slag wastes (ASW) from heat-and-power plants for several years have been on a path to developing new scientific methods in Russian as well as world science.

This research is urgently needed because resource-conserving and ecological problems are becoming more acute. Industrial wastes are byproducts of various manufacturing processes. The quantity of wastes increases continually as industries employing minerals as raw materials continue to grow. In the process, as ASW accumulate on storage grounds the payments for the resulting damage done to the environment increase, making it necessary to use new dumping grounds. This is not simply a local problem, it exists worldwide.

At the present time only a small part of the ash dumped is reprocessed or sold to secondary users, while ASW continue to accumulate in dumps. No one is engaged in thorough reprocessing of ASW [1]. Metallurgical slag is still used in the production of slag sital, since it is actually an alloy of silicates, commonly found in the chemical composition of sitals of this type [2]. The composition of the slag formed as a result of the combustion of solid fuel at heat-and-power plants is somewhat different from that of metallurgical slag. As a rule such slags contain large quantities of impurities, which are harmful to the ecology and degrade the operational properties of slag sitals. Consequently, salvaging such wastes is not a simple scientific-technical problem.

[1] South-Russia State Technological University, Novocherkassk, Russia.
[2] E-mail: e_yatsenko@mail.ru.

In this connection, from the scientific as well as practical standpoints it is of great interest to synthesize the compositions of glass-crystalline materials (slag sitals) based on slag from heat-and-power plants. The following problems must be solved for this:

develop slag-sital compositions using ASW from the Nesvetaiskaya State Region Electric Power Plant;

investigate the properties of synthesized materials;

develop the theoretical principles of slag-sital technology.

To help resolve these problems we performed an analytical review and patent search, which established that the slag produced as a result of burning solid fuel in a heat-and-power plant has a much different composition from that of metallurgical slags with high SiO_2, Al_2O_3, and Fe_2O_3 content.

Slag was taken from the Nesvetaiskaya State Regional Electric Power Plant because of the felicitous geographical location of this plant. Since this slag contains quite a large amount of Al_2O_3, which increase the refractoriness of the melt, low-melting compounds must be introduced into the mix in order to lower the melting temperature. It is also recommended that heavy-metal sulfides, TiO_2, Cr_2O_3, MgO, P_2O_5, CaF_2, and others be used as catalysts. The presence of Ca^{2+} in the melt improves the flowability of the slag; to achieve this we introduced $CaCO_3$ into the composition. In choosing modifiers we were guided not by their positive effect on the properties of the slag sitals synthesized and by their cost and availability.

On this basis we calculated the glass compositions needed to synthesize slag sitals (Table 1).

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TABLE 1.

Glass composition	Content of initial materials, wt.%								
	slag	$CaCO_3$	Cr_2O_3	Li_2CO_3	$MgCO_3$	$CaCO_3 \cdot MgCO_3$	pyritic cinders	MnO_2	Fe_2O_3
1	70	20	10	–	–	–	–	–	–
2	75	15	10	–	–	–	–	–	–
3	80	10	10	–	–	–	–	–	–
4	70	15	10	5	–	–	–	–	–
5	70	20	5	5	–	–	–	–	–
6	80	–	–	–	20	–	–	–	–
7	80	20	–	–	–	–	–	–	–
8	80	15	–	5	–	–	–	–	–
9	80	–	–	–	–	20	–	–	–
10	80	–	–	5	–	15	–	–	–
11	80	15	–	–	–	–	5	–	–
12	80	15	–	–	–	–	–	5	–
13	80	10	–	5	–	–	–	–	5
14	80	10	–	5	–	–	–	5	–
15	80	–	–	–	–	15	5	–	–
16	80	–	–	–	–	10	10	–	–
17	80	–	–	–	–	15	–	–	5
18	80	15	–	–	–	–	5	–	–
19	80	10	–	–	–	–	5	5	–
20	80	5	–	5	–	–	5	5	–
21	80	5	–	5	–	–	10	–	–

The compositions were melted using different temperature regimes in order to determine the optimal melting temperature of these glasses.

Glass-Making Regimes

Glass-making temperature range, °C. . . . . . 1300 – 1550
Glass-making temperature, °C:
maximum 1550
optimal 1500
Soaking time, min . . . . 20 – 50
Optimal soaking time, min 40

It was found that the optimal glass-making temperature for the synthesized glasses is 1500°C and the optimal soaking time at the maximum temperature is 40 min.

In terms of the founding quality, color, and sheen the samples 7, 11, 12, and 19 exhibited the best results. It was also found that $CaCO_3$ does have a positive effect on the quality of the glass, since the quality of glasses containing the lowest amount of or no $CaCO_3$ is unsatisfactory (compositions 10, 13, 15, and 20), while the glasses containing at least 15% $CaCO_3$ are distinguished by satisfactory quality. In addition, the presence of pyritic cinders (compositions 16, 18, 20, and 21) has a negative effect on the quality of the synthesized glasses. These glasses are characterized by an abundance of frozen foam on their surface. The best results were obtained for glasses with the compositions 7, 11, 12,

TABLE 2.

Glass composition	Crystallization temperature	Crystallization degree
7	700	Crystallization absent
	800	Surface crystallization in the form of individual sections
	900	Surface crystallization and individual crystals in the bulk
	1000	Volume crystallization
11	700	Crystallization absent
	800	Surface crystallization
	900	Surface crystallization and individual crystals in the bulk
	1000	Volume crystallization
12	700	Crystallization absent
	800	Surface crystallization in the form of individual sections
	900	Surface crystallization and individual crystals in the bulk
	1000	Volume crystallization
19	700	Crystallization absent
	800	Surface crystallization
	900	Surface crystallization and individual crystals in the bulk
	1000	Volume crystallization

and 19. These compositions were taken as the basis for obtaining slag sitals.

The crystallization power of the synthesized glasses was studied to determine the possibility of using the compositions indicated to obtain slag sitals. It was found that crystallization does not occur at temperatures below 900°C (700 and 800°C). Surface crystallization is observed at 900°C and volume crystallization at 1000°C (Table 2).

It is evident from the data in Table 2 that all synthesized glasses can crystallize; volume crystallization is observed for all samples at 1000°C. These compositions can become the basis for developing a resource-conserving technology for glass crystalline materials (slag sitals).

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